The influence of temperature and dolomite catalyst onthe pyrolysis of corn stover.

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Introduction

Biomass has major interest as a renewable energy source in the context of climate change, mitigation and energy security. Energy from biomass is based in short rotation forestry and energy crops that can contribute to the energy needs of the modern society (Bridgewater, 2003). Pyrolysis, as one of the promising thermochemical conversion routes, plays a vital role in biomass conversion. For the most applications, the gas should be cleaned to reduce the content of dust and tar (Narváez et al., 1997). Tar formed during biomass pyrolysis is one of the major issues, since catalytic pyrolysis or gasification for tar reduction had been extensively reported in the literatures. The use of dolomite as catalysts in biomass pyrolysis or gasification had been attracted much attention, because it was inexpensive and abundant and it could significantly reduce tar content of the product gas.

The aim of this work was to determine the influence of the pyrolysis temperature and the presence of calcined dolomite catalyst on the pyrolysis products yields and on its composition.

Materials and methods

Corn stover

The material employed in this study was corn stover which was collected from Zaragoza (Spain). The sample was crushed to a particle size between 75 and 125 μm.

Catalyst

Dolomite catalyst was used for the reforming of syngas produced in the decomposition of corn stover. Dolomite used is known as dolomite “Malaga” whose composition approximate weight % is: 30–35% CaO, 20–24% MgO, 45–48% CO_2. Dolomite was crushed and sieved to a size between 2.0 and 1.0 mm. Afterwards, dolomite was introduced into a furnace to be calcined at absent CO_2 atmosphere at 850 ºC for 12 h.

Pyrolysis

The experimental system includes a fixed bed reactor, externally heated by an electrical furnace, and an ice-water bath which was used to trap higher boiling point substances produced during pyrolysis. The reactor was constructed of stainless steel and the size was 2.5 cm diameter and 50 cm high.

When the experiment started, the corn stover or the corn stover/dolomite mix (corn stover/dolomite ratio was 1/1) were placed in the reactor. Then nitrogen was passed through the reactor during 1 hour. Nitrogen flow was 50 ml/min. Once the inertisation by nitrogen is finished, the reactor was heated from room temperature to the temperature required for each experiment (350, 450, 550, 650 and 750 ºC) at a heating rate of 10K/min, and held the temperature until no further significant release of gas was observed. The pyrolysis gases after passing the ice cooling trap were analysed in a microGC (Varian Inc,CP-4900) and the liquid condensed was collected into the sample bottle.

Results

The effects of temperature and the effect of calcined dolomite catalyst on product yields were shown in Figures 1 and 2 respectively.

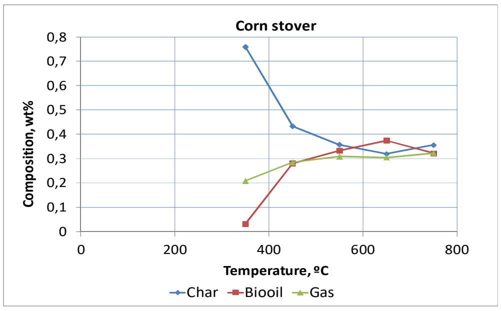

Figure 1. Corn stover pyrolysis.

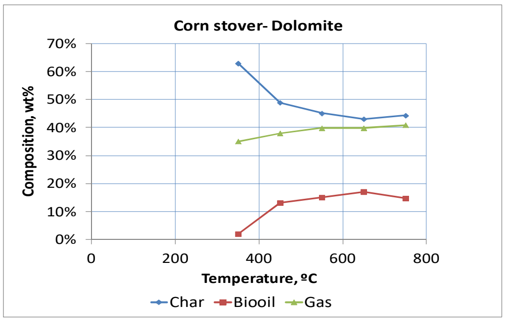

Figure 2. Corn stover/dolomite catalyst pyrolysis.

The effects of temperature and the effect of calcined dolomite catalyst on product gas composition were shown in Figures 3 to 7 for corn stover pyrolysis and Figures 8 to 12 for corn stover/dolomite catalyst pyrolysis..

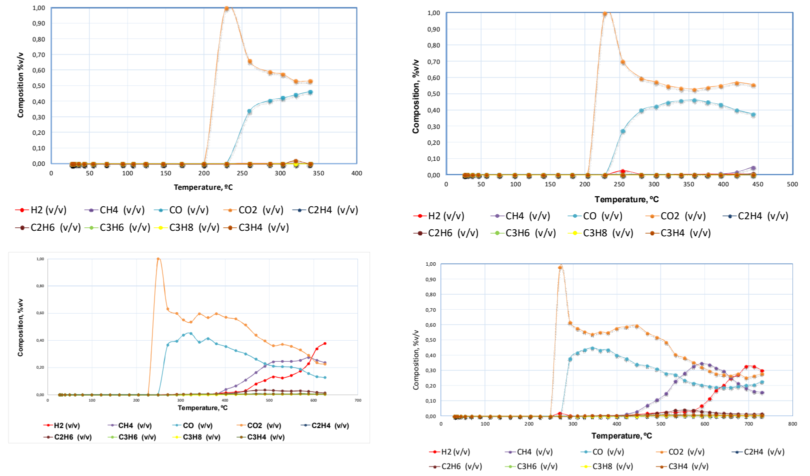

Figure 3 to 7. Corn stover pyrolysis

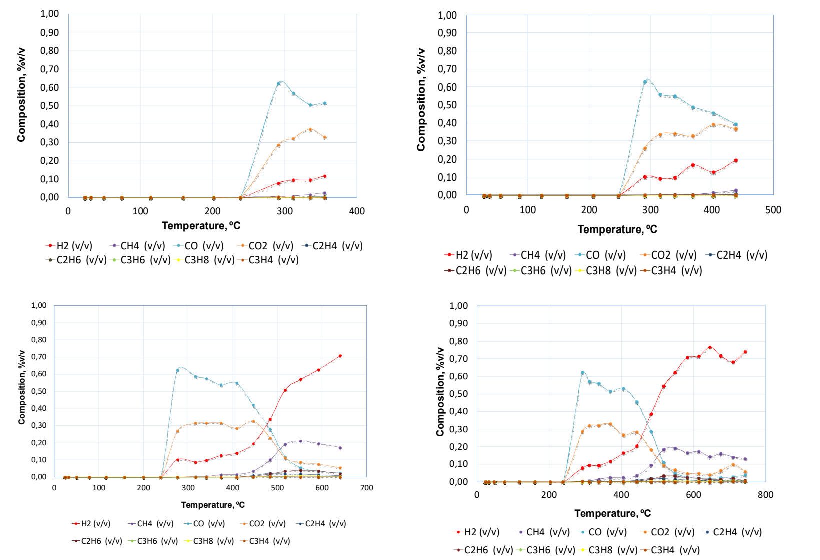

Figure 8 to 12. Corn stover/dolomite catalyst pyrolysis.

Conclusions

In this study, the effect of temperature and the presence of dolomite catalyst on products yield were investigated. The solid yield (char) decreased with the pyrolysis temperature form 350 to 650 ºC and then decreased slightly up to 750 ºC. The liquid yield (biooil) increased with the pyrolysis temperature form 350 to 650 ºC and then decreased up to 750 ºC. The maximum oil yield of 37.5 wt% was obtained at 650 ºC. The gas yield increased from 21% to 32% with the increasing pyrolysis temperature. On the other hand, the use of calcined dolomite catalyst in the corn stover pyrolysis reduces the biooil yield from 450 ºC.

Regarding to the effect of temperature and the presence of dolomite catalyst on gas product composition, the H_2 content increases with temperature and is higher when using the catalyst. The CO content is higher at low temperatures (300-400 ºC) when we use the catalyst and is lower at medium/high temperatures (400-750 ºC). The CO_2 content is lower for all temperatures when we use the catalyst.

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